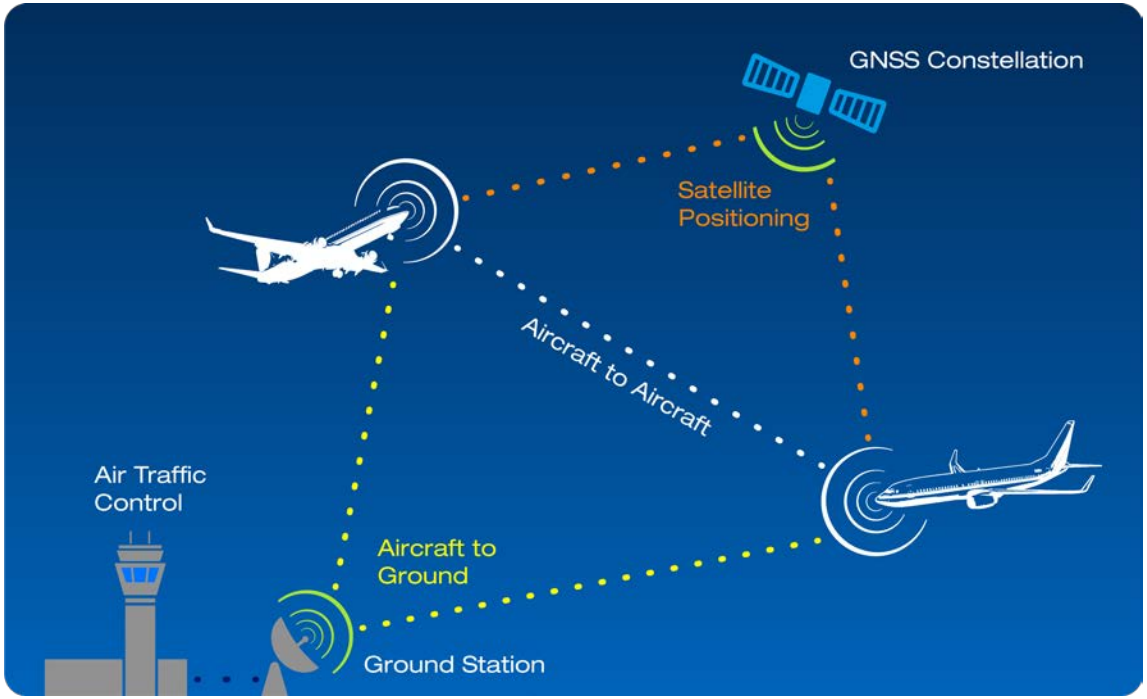
ATO Program Management Organization

ADS-B Program Status



Presented to: A4A CNS Task Force

By: Doug Arbuckle

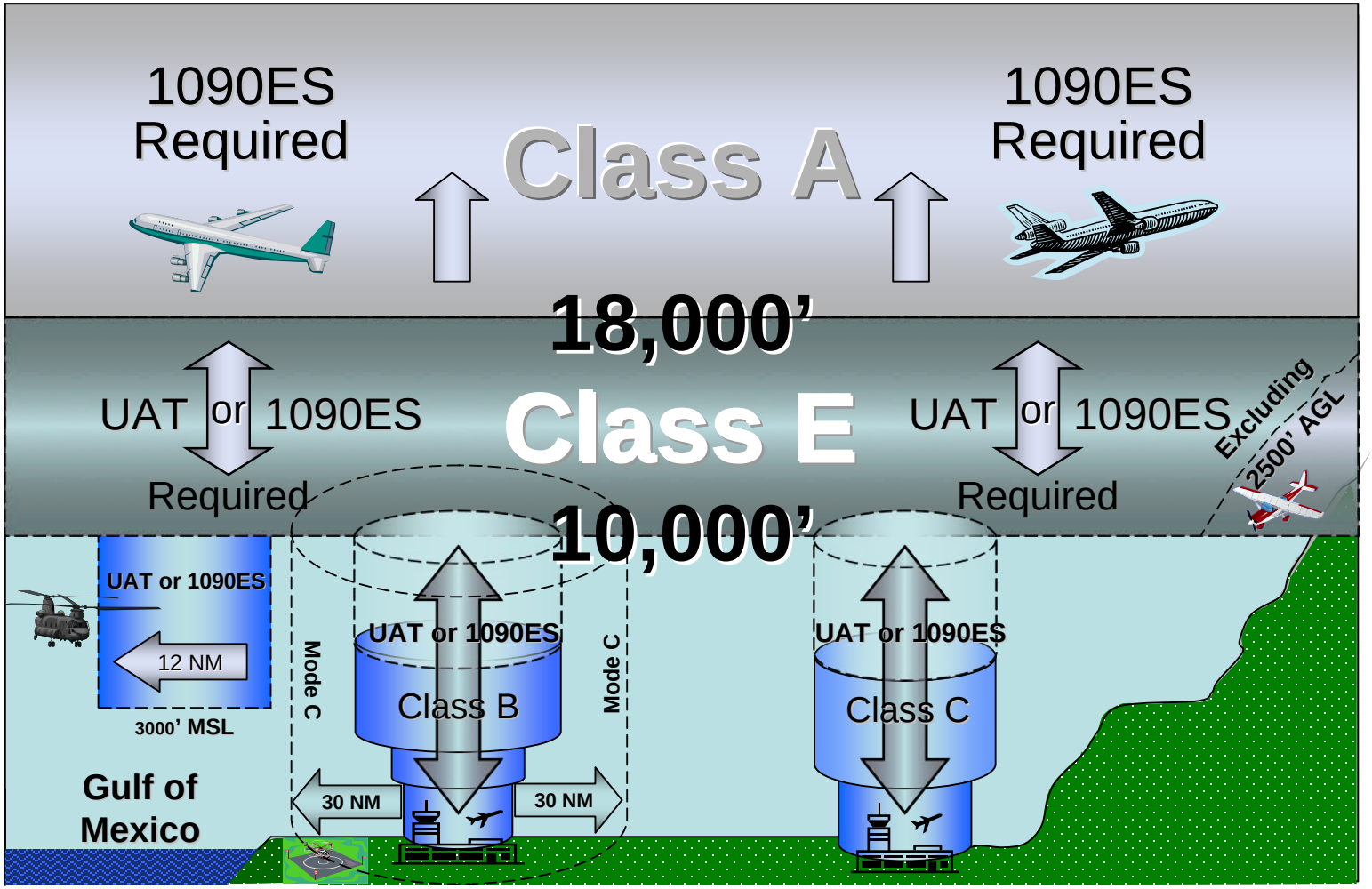
Date: December 12, 2018

ADS-B Out Rulemaking

January 1, 2020, the FAA Final Rule for ADS-B Out equipage

- Published on May 27, 2010
- This rule applies to aircraft that desire to access certain airspace (14 CFR 91.225)
- This rule mandates performance requirements for ADS-B avionics that fly in certain airspace (14 CFR 91.227)
- ADS-B Out transmits location information received from the Global Navigation Satellite System (GNSS) out of the aircraft to ADS-B receiver stations and to other aircraft equipped to receive ADS-B broadcasts. The rule does not preclude other navigation source methods.
- This rule applies to all airspace that requires a transponder today
- This rule does not mandate ADS-B In

Required ADS-B Airspace



Visit https://www.faa.gov/nextgen/equipadsb/research/airspace/

Exemption 12555 Summary

- **not an extension of the rule compliance date**
- **a five year limited exemption only from 91.227(c)(1)(i) & (iii) – the NIC and NACp requirements – under the following conditions and limitations:**
  - Each operator seeking exemption must have sent their application to FAA by 1-Aug-2018
  - Operators of SA-Aware equipped aircraft with the Exemption are not required to conduct preflight verification; such operators are exempted from the performance requirements in 14 CFR §91.225 when their ADS-B Out equipment is not predicted to meet the requirements of §91.227(c)(1)(i) and (iii)
  - Operators of SA-On equipped aircraft must conduct preflight verification; operators with the Exemption may operate in airspace specified in §91.225 when their ADS-B Out equipment does not meet the requirements of §91.227(c)(1)(i) or (iii) **and** the FAA determines there is a backup means of surveillance
    - FAA will make this determination available through the Service Availability Prediction Tool (SAPT)

Service Delivery Points for ATC Separation Services									
	FY10 – FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	Operational
En Route	6	4	12	2	N/A	N/A	N/A	N/A	24 of 24
Terminal	19	27	17	5	13	24	26	2 of 24	133 of 155
Surface (Advisory)	16	10	9	0	1	1	1	5	38 of 43
Oceanic	0	0	0	1	1	1	N/A	N/A	3 of 3

U.S. Rule-Compliant ADS-B Out Avionics Equipage 62,142

ATC Spacing Services

Ground-Based Interval Mgmt - Spacing (GIM-S) (En Route only)

2011 - 2014: GIM-S Develop → 2013 - 2014: GIM-S Deploy → ⊗ → 2014: GIM-S Test → 2014: GIM-S IOC → 2020 Avionics Equipage

Flight Deck Based Interval Mgmt– Spacing (FIM-S)

In Trail Procedures (ITP)

Traffic Situation Awareness with Alerts (TSAA)

Pilot Applications

U.S. ADS-B In Avionics Equipage 50,449

Pilot Advisory Services			
	FY14-FY18	FY19	Total
Baseline Deployment (2008 – 2014)			Complete
Alaska Expansion Deployment			Complete
Service Expansion Deployment (ASSC and Gulf of Mexico* Service Volumes)	5	2 of 4	7 of 9

TIS-B
FIS-B
ADS-R

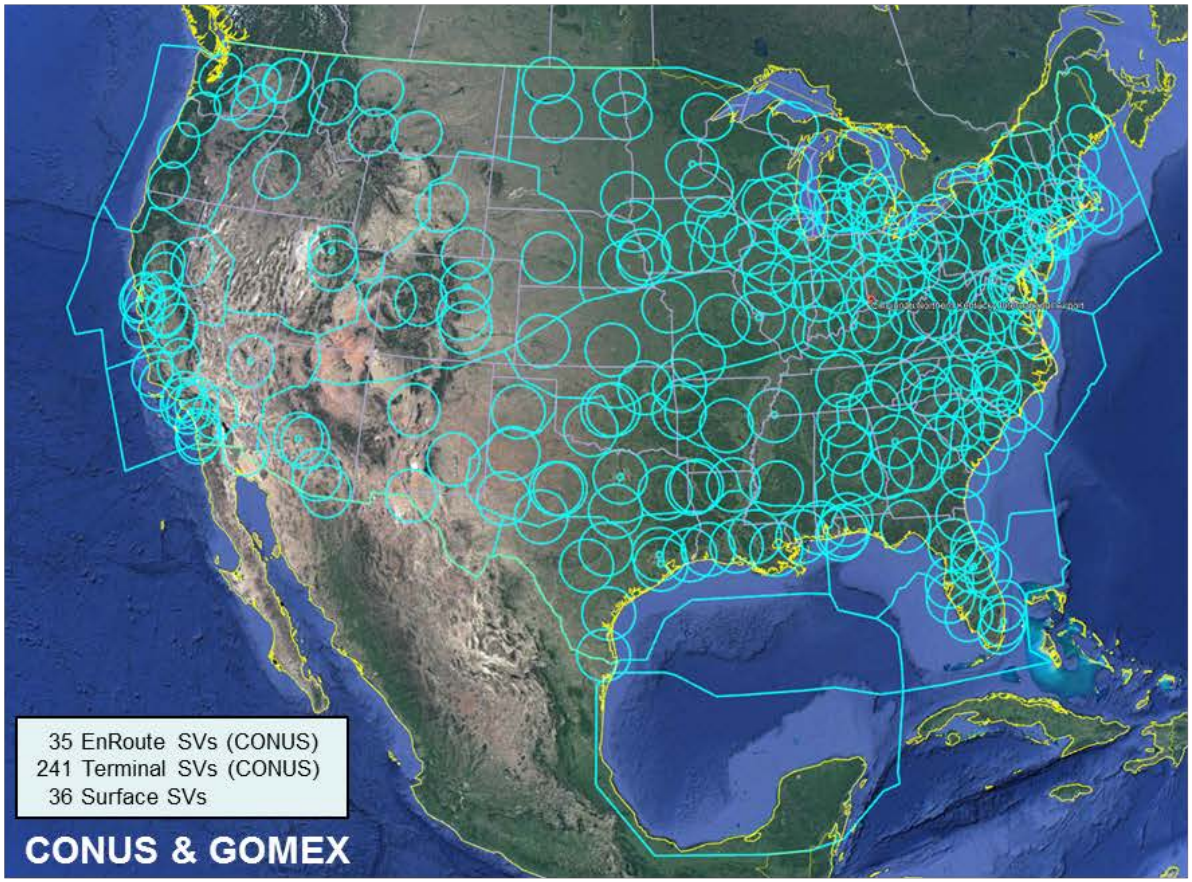
In Process

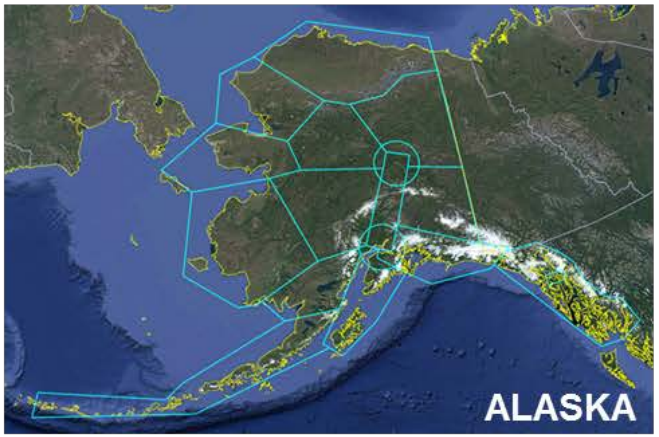
Complete

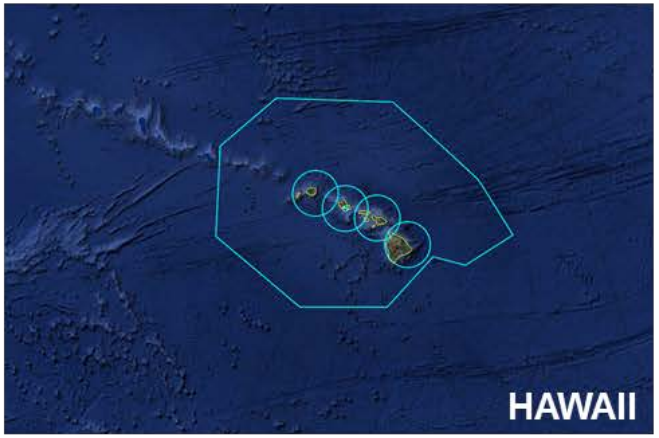
**Pilot services not provided in Mexican Service Volumes*

As 12-01-2018

ADS-B Service Volumes: EnRoute, Terminal, and Surface







As of 1-Dec-18

December 2018 Equipage(good installs)

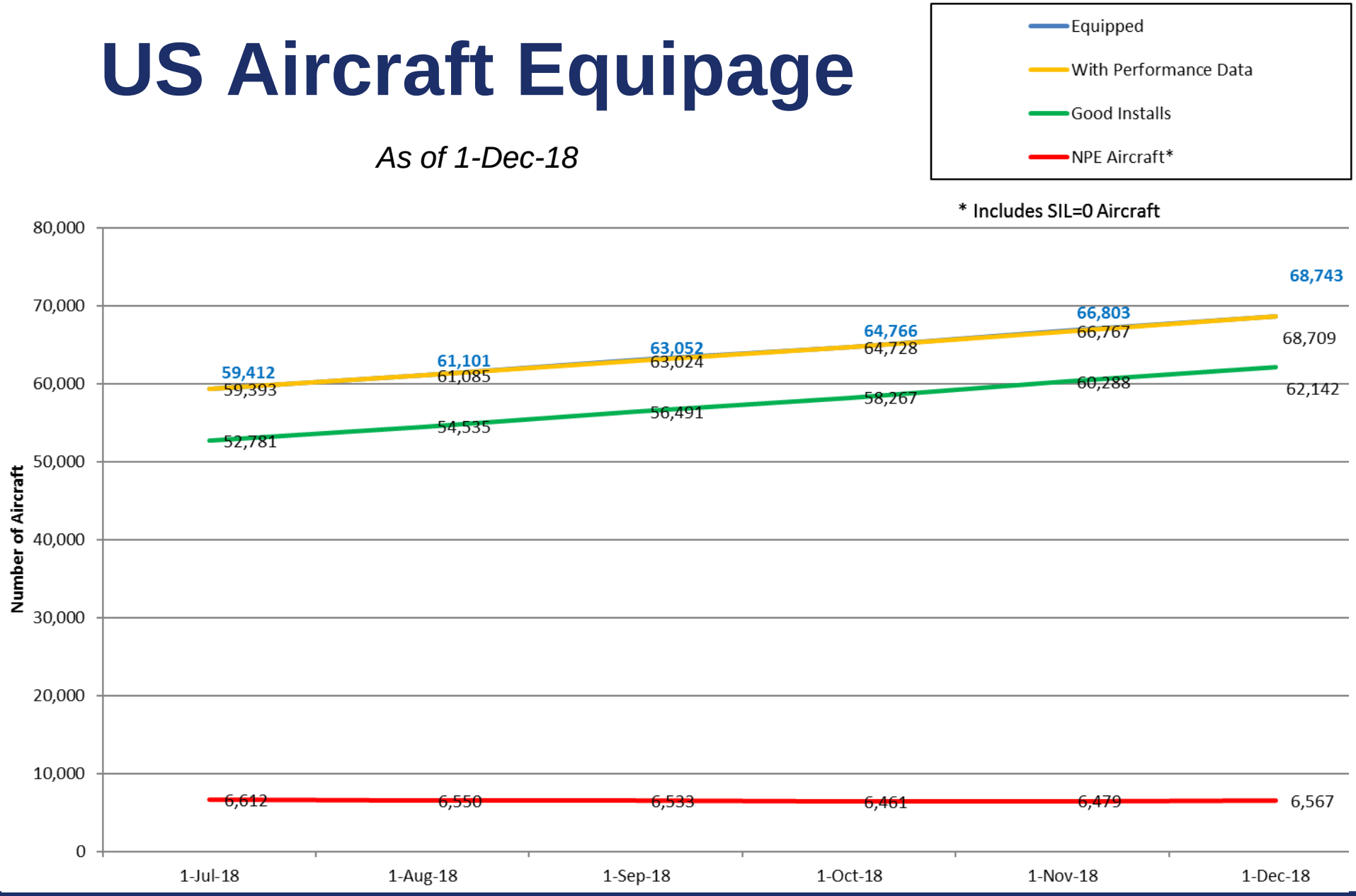
Rule Driven ADS-B Out Aircraft Detected by FAA network

Category	As of 1-November 2018 (ATAT)	As of 1-December 2018 (ATAT)	Monthly Increase	
All Link Version 2	60,290	62,142	1,852	3.07%
1090ES	52,454	54,161	1,707	3.25%
UAT	6,866	7,008	142	2.07%
Dual	968	973	5	0.52%
US General Aviation (includes EXP & LSA)	48,757	50,167	1,410	2.89%
US Air Carrier	3,215	3,492	277	8.62%
Intl General Aviation*	3,599	3,732	133	3.70%
Intl Air Carrier	1,200	1,249	49	4.08%
U.S. Military & U.S. Special Use	618	677	59	9.55%

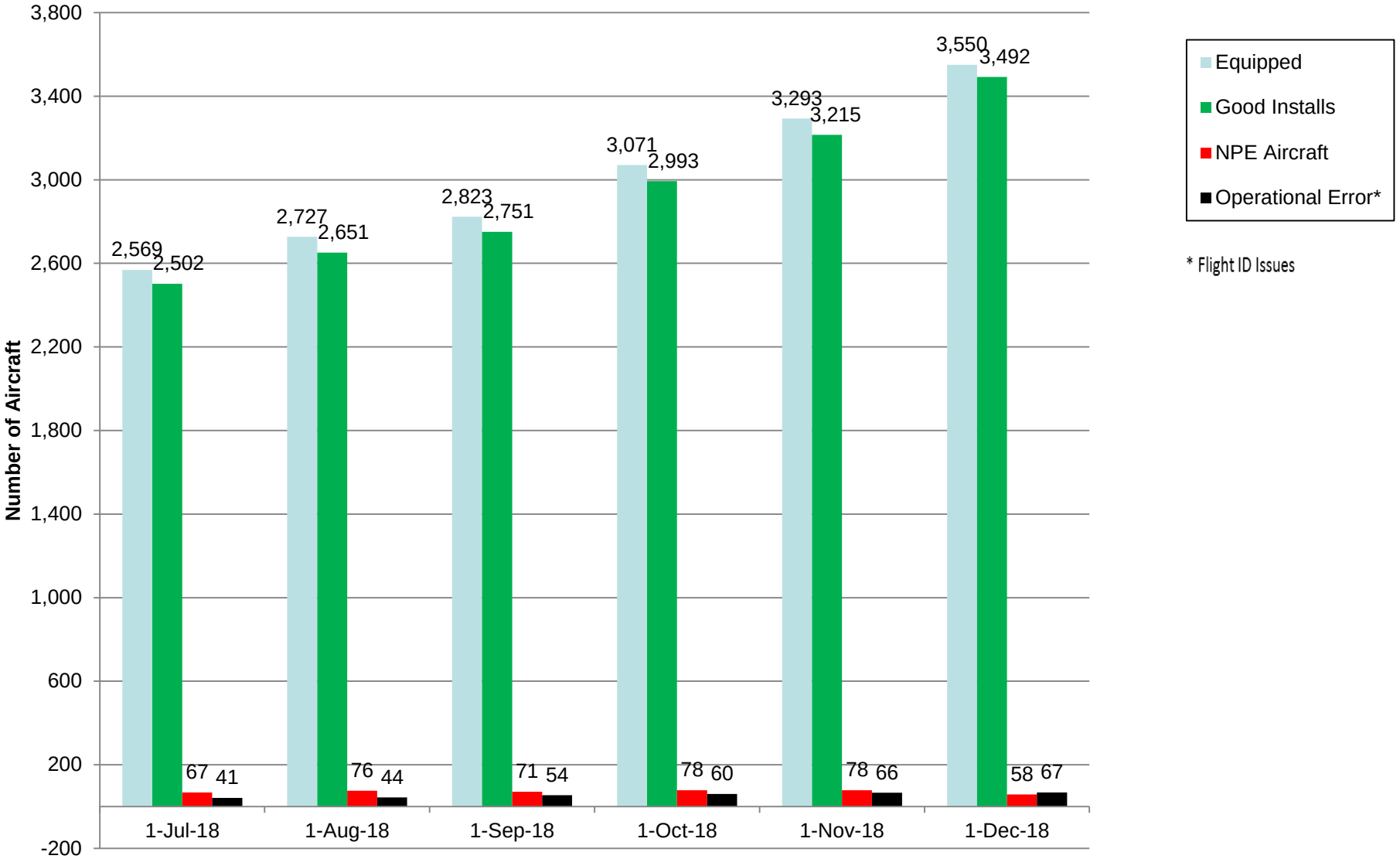
*Aircraft incorrectly reporting outside US ICAO block are included in Intl GA count.

US Aircraft Equipage

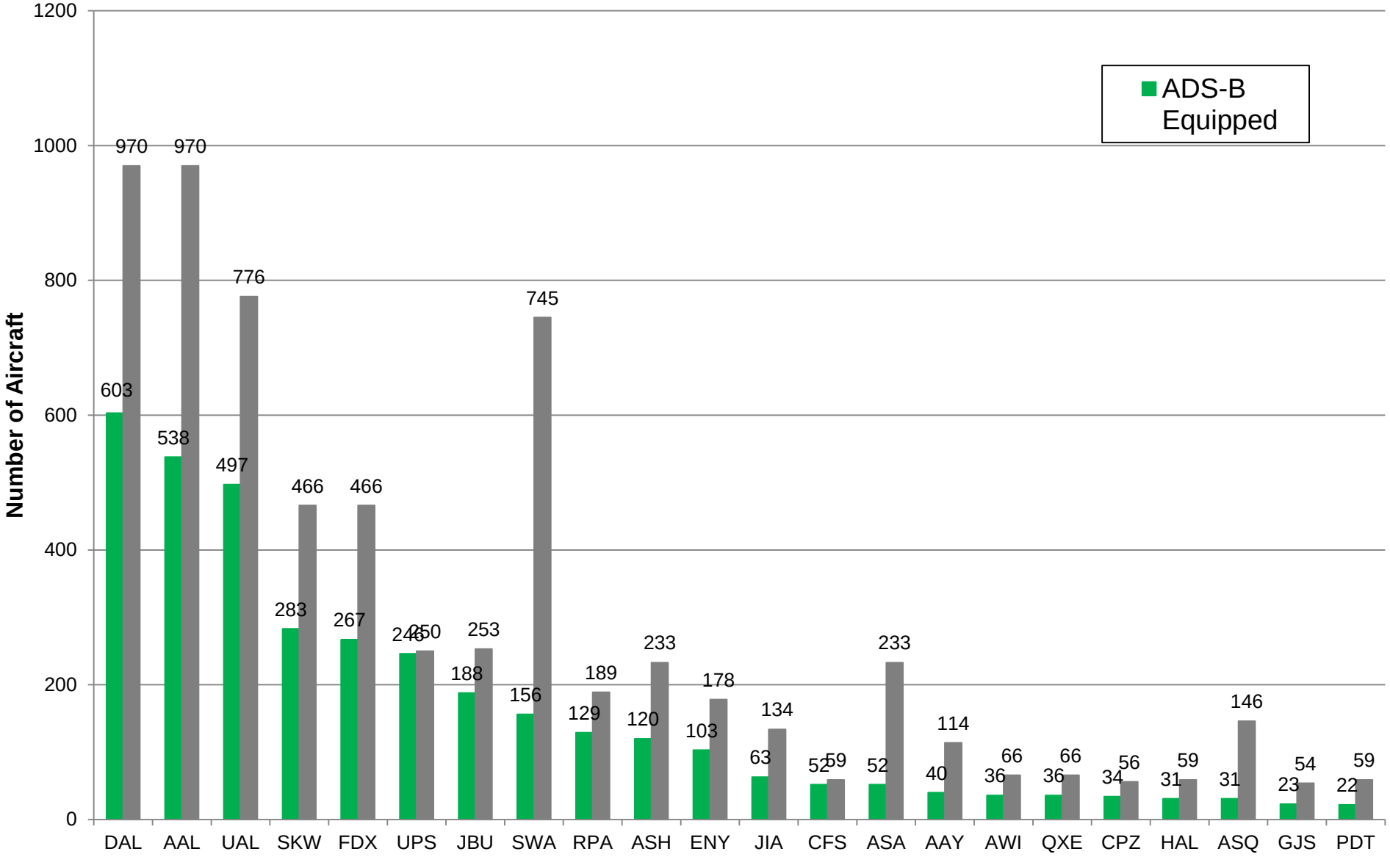
As of 1-Dec-18



US Air Carrier Equipage & Avionics Performance



Equipage Status - U.S. Air Carriers as of 1-Dec-2018

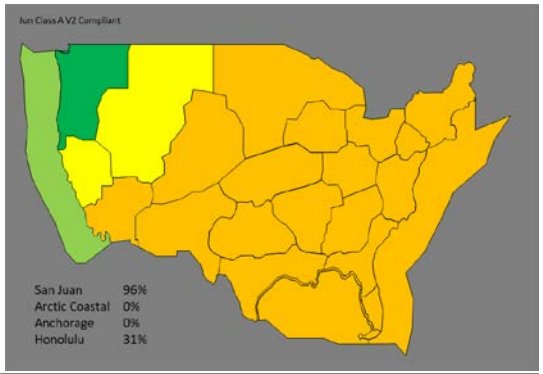


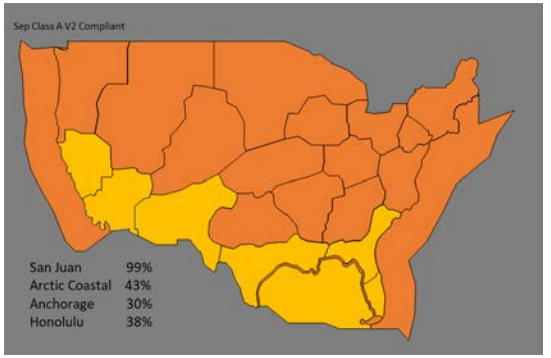
Equipped Operations – Heat Maps

Percent ADS-B Out V2 Compliant Jun 2018 to Sep 2018

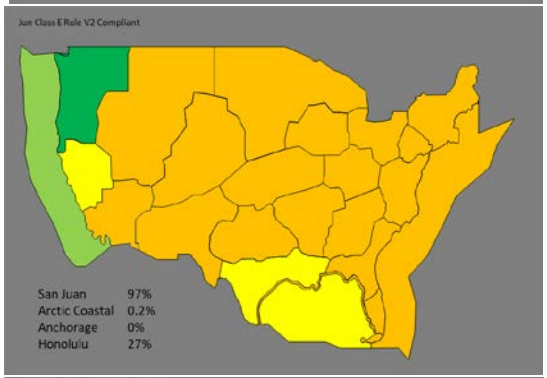
Percent Equipped
50+
40-49
30-39
20-29
10-14
0-9
No data

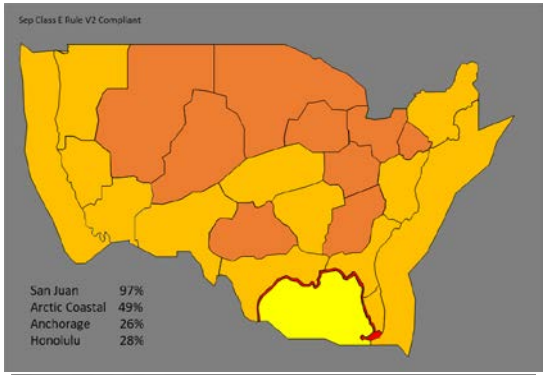
Class A



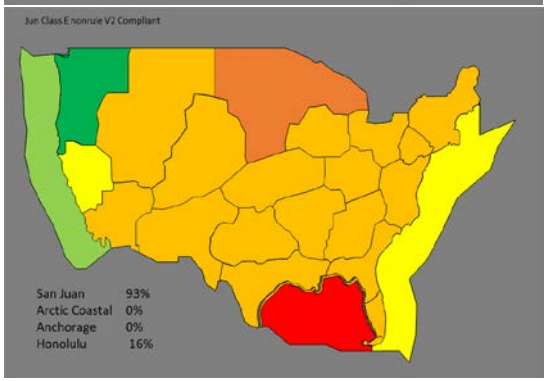


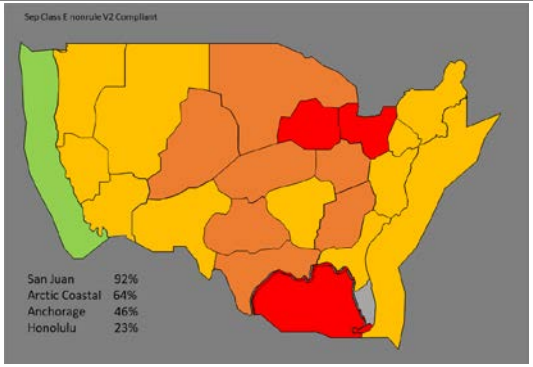
Class E Rule Airspace





Class E Non-Rule Airspace

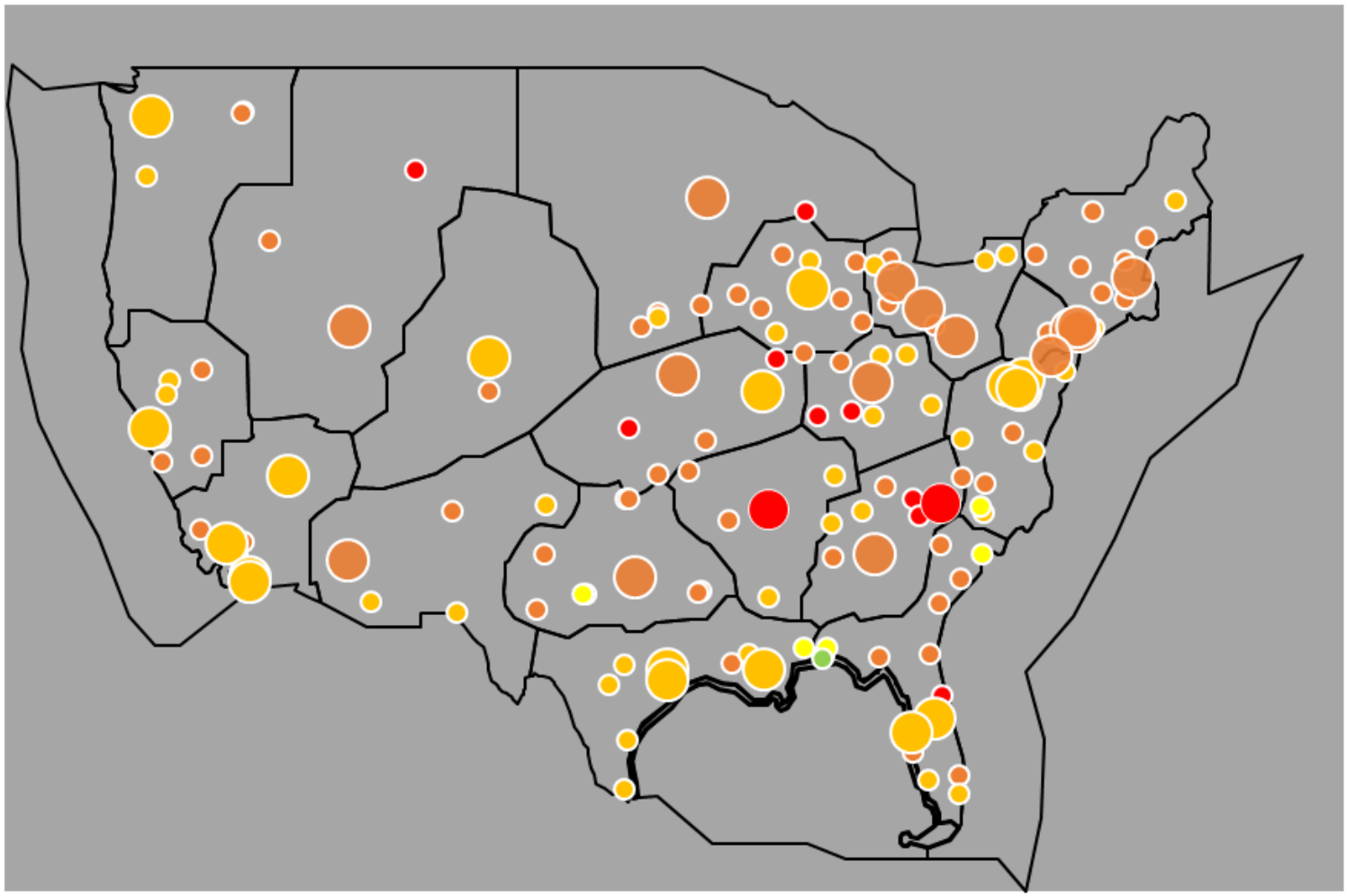




Equipped Operations – Heat Maps

Sep 2018 (Class B with Mode C Veil and Class C airports) V2 compliant

Percent Equipped
50+
40-49
30-39
20-29
10-19
0-9

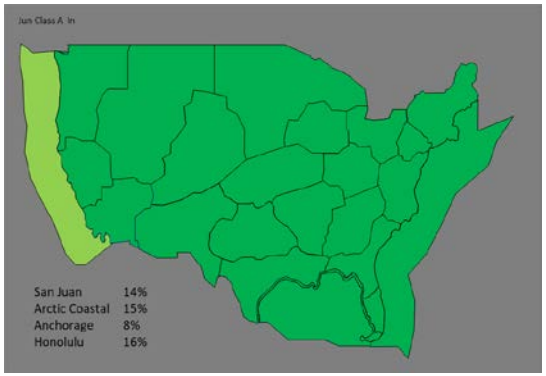


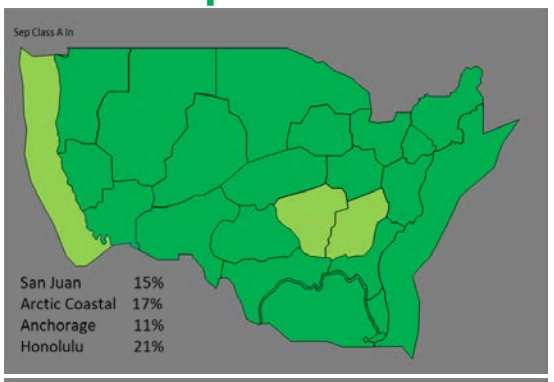
Equipped Operations – Heat Maps

Percent ADS-B IN Jun 2018 to Sep 2018

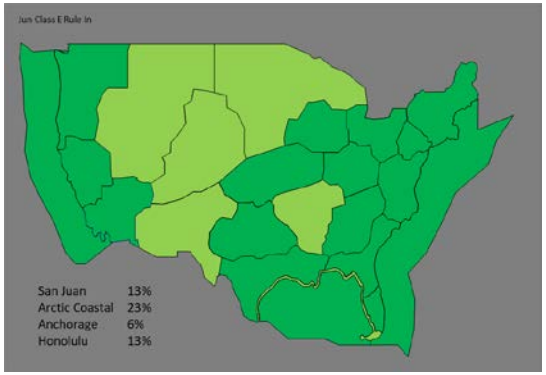
Percent Equipped
50+
40-49
30-39
20-29
10-14
0-9
No data

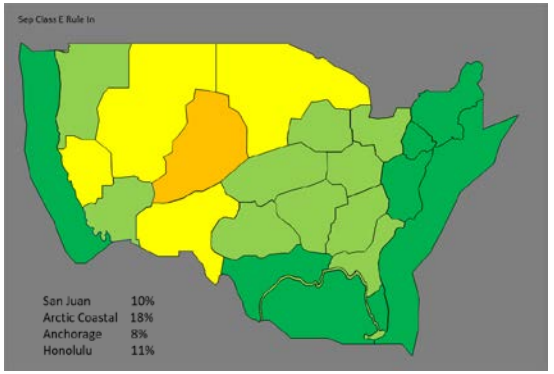
Class A



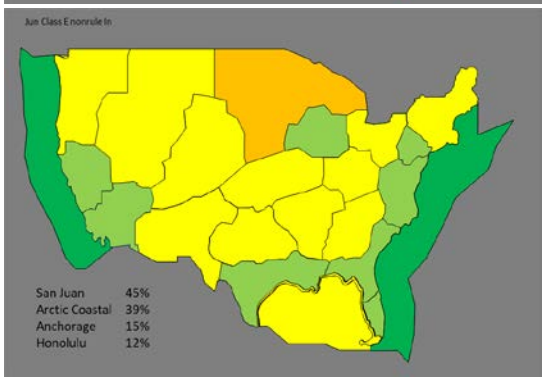


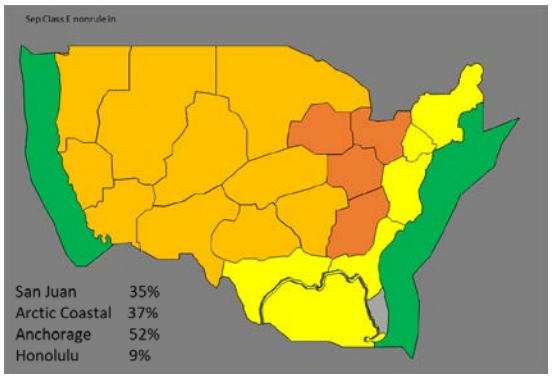
Class E Rule Airspace





Class E Non-Rule Airspace





Equipped Operations

Summary Sep 2018

September 1 - 15, 2018	Class	ADS-B Out V2 %	ADS-B Out V2 Compliant %	ADS-B IN %
Terminal Rule-Airspace	Class B	41.2%	39.9%	15.0%
	Class C	41.6%	40.3%	17.2%
Terminal Non-Rule-Airspace	Class D	44.6%	41.7%	27.2%
En-Route Rule-Airspace	Class A	42.3%	41.4%	8.1%
	Class E	40.4%	39.4%	10.0%
En-Route Non-Rule-Airspace	Class E	47.8%	43.3%	35.2%

June 2018	Class	ADS-B Out V2 %	ADS-B Out V2 Compliant %	ADS-B IN %
Terminal Rule-Airspace	Class B	35.8%	33.0%	13.3%
	Class C	35.5%	31.4%	13.1%
Terminal Non-Rule-Airspace	Class D	44.3%	34.0%	30.6%
En-Route Rule-Airspace	Class A	36.0%	32.1%	6.8%
	Class E	34.4%	30.8%	8.5%
En-Route Non-Rule-Airspace	Class E	38.7%	32.6%	23.1%

Equipped Operations

Summary Sep 2018 Top Performing SVs by Percent equipped

Sep 1 - 15, 2018	Class	ADS-B Out V2 %		ADS-B Out V2 Compliant %		ADS-B IN %	
Terminal Rule-Airspace	Class B	54.2%	Memphis, TN	52.4%	Charlotte, NC	31.9%	Memphis, TN
		53.2%	Charlotte, NC	51.5%	Memphis, TN	25.6%	Atlanta, GA
		48.9%	Boston, MA	48.0%	Boston, MA	23.9%	Phoenix, AZ
		48.5%	Atlanta, GA	46.8%	Pittsburgh, PA	23.2%	St. Louis, MO
		47.8%	Pittsburgh, PA	46.6%	Atlanta, GA	22.9%	Boston, MA
	Class C	99.6%	St. Thomas, VI	94.9%	San Juan, PR	73.9%	St. Thomas, VI
		99.4%	San Juan, PR	93.8%	St. Thomas, VI	54.7%	Daytona Beach, FL
		73.3%	Asheville, NC	68.5%	Asheville, NC	49.3%	Billings, MT
		65.4%	Billings, MT	58.9%	Daytona Beach, FL	45.7%	San Juan, PR
		60.4%	Daytona Beach, FL	55.6%	Billings, MT	40.0%	Asheville, NC
Terminal Non-Rule Airspace	Class D	76.6%	Bakersfield, CA	74.8%	Bakersfield, CA	60.5%	Lynchburg, VA
		74.3%	Casper, WY	67.0%	Lynchburg, VA	50.3%	Casper, WY
		67.8%	Lynchburg, VA	62.7%	Rockford, IL	42.5%	Bakersfield, CA
		64.0%	Rockford, IL	57.8%	Mesa, AZ	41.6%	Mesa, AZ
		59.8%	Nantucket, MA	56.7%	Casper, WY	41.1%	Otis AFB
En-Route Rule-Airspace	Class A	98.2%	San Juan	94.0%	San Juan	19.3%	AK Peninsula
		54.3%	AK Peninsula	44.7%	Salt Lake City	17.9%	Honolulu
	Class E	98.5%	San Juan	96.5%	San Juan	27.3%	Southeast AK
		50.4%	Arctic Coastal	48.8%	Arctic Coastal	19.9%	Salt Lake City
En-Route Non-Rule-Airspace	Class E	97.3%	San Juan	92.0%	San Juan	81.6%	Southeast AK
		87.2%	Southeast AK	77.9%	Yukon - Kuskokwim Delta	67.9%	Yukon - Kuskokwim Delta

FAA currently tracked ADS-B avionics problems

- **Baro/Geo Altitude Spikes**
- **Missing Baro Altitude**
- **Missing Flight ID**
- **Missing Mode 3/A**

Unique to UAT

- **Kinematic Issues (aka, “position jumping”)**
- **Duplicate & Wrong ICAOs**
- **Air/Ground determination issues**
- **Incorrect Emitter Category**
- **Flight ID Error (includes Partial Flight ID)**

Both links

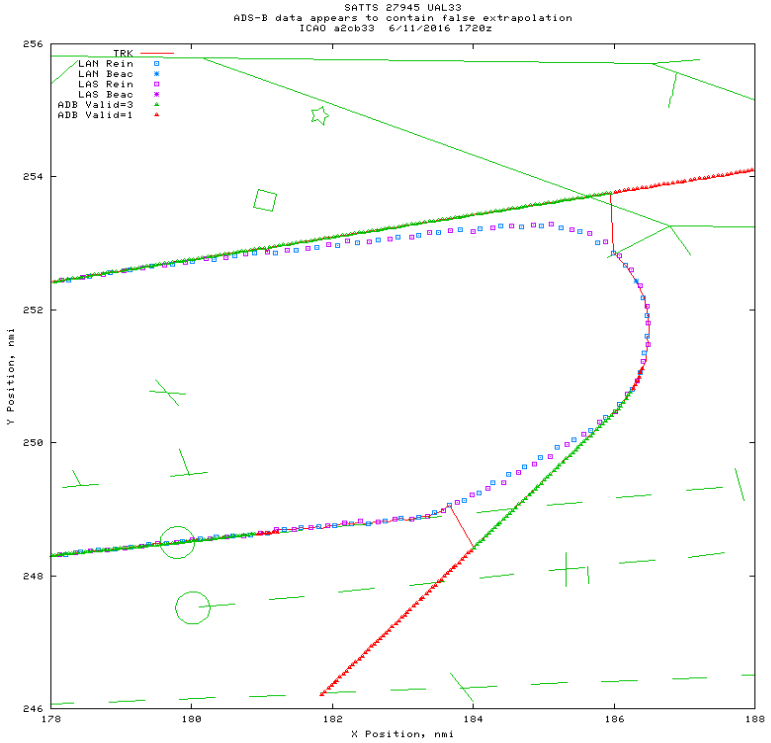
- **B787 and TSS-4100 (Rockwell ProLine TCAS/transponder unit) erroneous position *(Airworthiness Directives issued)***
- **E170 position jumping**
- **A380 Flight ID change on Surface**
- **A380 Geo Altitude (SB available)**
- **B777-300ERs delivered with wiring error, resulting in non-compliant NACv/SDA/EmitCat/Length-Width Code (SB available)**
- **Airbus single aisle missing Length-Width Code due to production wiring error (SB available)**

Unique to 1090

B787 avionics problem

Issue

- 11-Jun-2016, UAL33, on downwind for final approach at LAX (see picture, right)
- B787 Integrated Surveillance System (ISS) extrapolated position along a straight line based on current track, while sending “good” quality parameters
- Problem detected by SBS validation after radar and ADS-B positions differed by 0.56nm (where green line becomes red)
- FAA ADS-B Performance Monitor observed multiple additional arrival & departure events on different B787s in 2016-2017
- Problem has not reoccurred yet on same aircraft



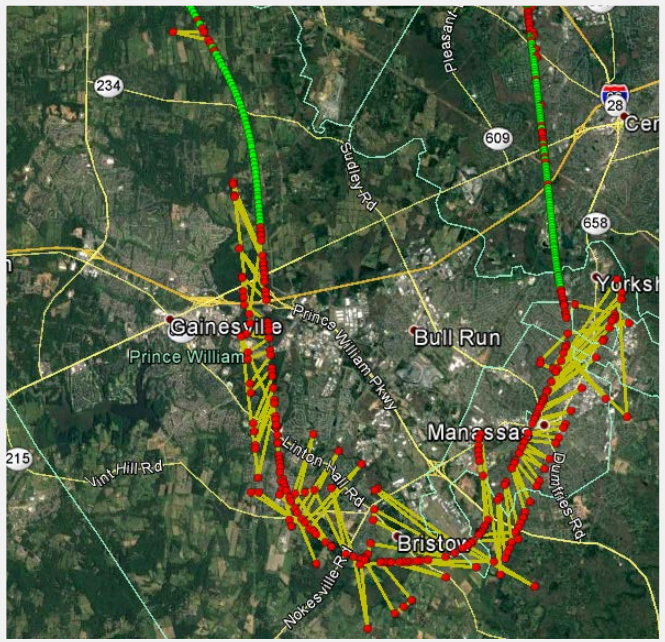
Solution(s)

- Boeing/Rockwell determined root cause; Boeing implemented fix for production aircraft starting with Line# 542; Service Bulletin B787-81205-SB340036-00 available
- FAA implemented tighter position validation within 15nm of airports with an SSR and implemented a No Services Aircraft List (https://www.federalregister.gov/documents/2017/12/20/2017-27202/change-to-automatic-dependent-surveillance-broadcast-services)
- FAA issued Airworthiness Directive 2017-NM-118-AD, effective 10-Dec-2018, which requires application of above listed Boeing SB within one year

E170 avionics problem

Issue

- **In late October 2016, a Skywest E170 was detected exhibiting "track jumping"**
  - FAA Air Traffic personnel notified Flight Standards, who contacted operator and ordered replacement of the transponders
  - Unfortunately, these transponders were returned to a service center without notification to Honeywell engineering, and no debugging testing was performed
- **In late July 2017, early August 2017, and mid-January 2018, FAA detected E170 aircraft from two different airlines exhibiting "track jumping" behavior**
  - FAA notified both operators and Honeywell engineering, and the transponders were removed from the aircraft and sent to Honeywell engineering for testing. Bench testing revealed no apparent issues.
- **In all cases to date, removing and replacing transponders cleared issue – problem has not reoccurred on same aircraft**
  - Bench testing of removed transponders has revealed no anomalies
  - FAA has decided that next E170 aircraft detected with this issue will be immediately placed on No Services Aircraft List (NSAL); simultaneously, FAA will notify Embraer and Honeywell and request that appropriate engineering personnel be sent to inspect and test affected aircraft



Solution(s)

- **Use NSAL as "defense"**
- **Avionics root cause TBD**

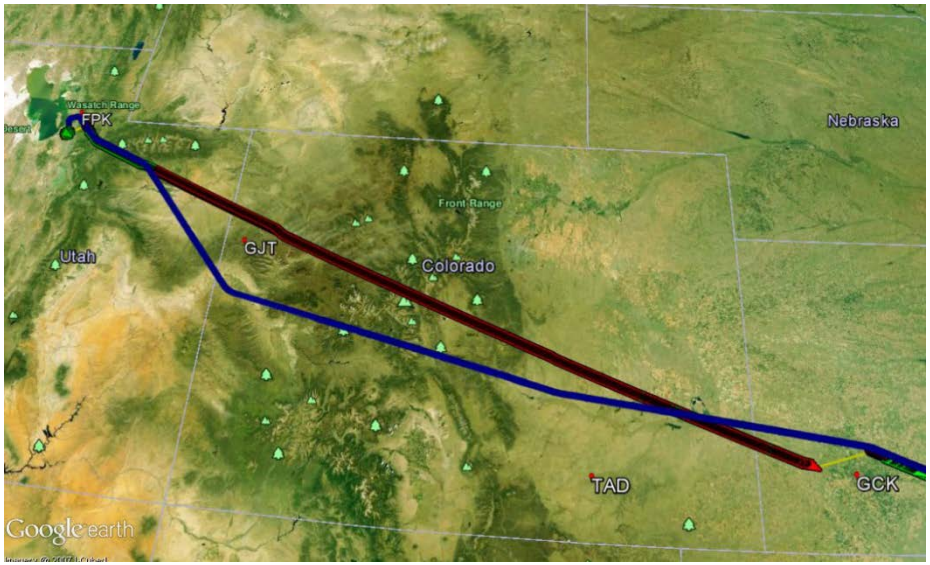
TSS-4100 issue

Issue

- **On 21 Dec 2017, FAA monitoring observed a track extrapolation by an Embraer business jet equipped with a Rockwell Collins TSS-4100 transponder**
  - –track extrapolation lasted for over 450nm
- **TSS-4100 shares software with B787 ISS, so software defect in B787 ISS also exists in TSS-4100**

Solution(s)

- **Rockwell Collins reported TSS-4100 TSO noncompliance to FAA once the B787 ISS software issue was diagnosed; TSS-4100 shipments were stopped until software defect was corrected**
- **Airworthiness Directive (AD) 2017-22-14 was issued on 20 Dec 2017 and can be found online at:**
  http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgad.nsf/0/f2fdf0b259d98ea4862581d9004fa2d1/$FILE/2017-22-14.pdf
- **Compliance date for this AD is 20 Dec 2018 *(or 750 hours in service, whichever occurs first)***



Solution(s), continued

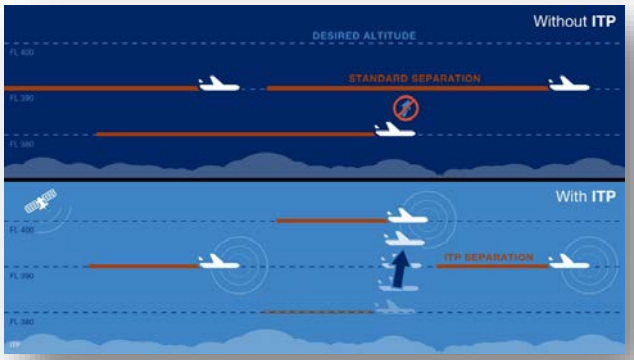
- **FAA determined that actions required by AD had not been performed**
- **After communicating with operator, FAA placed this aircraft on No Services Aircraft List (NSAL) until actions required under AD 2017-22-14 were completed; aircraft has since been removed from NSAL**

ADS-B In Future Applications

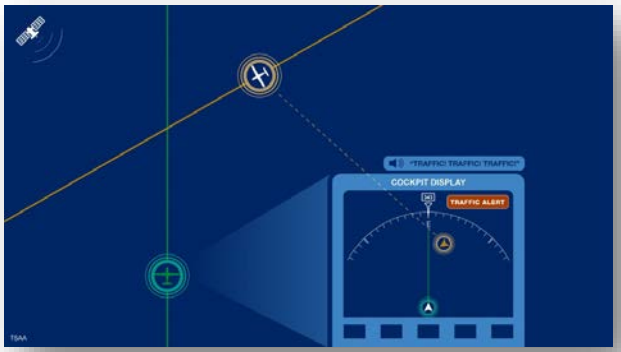
- **ADS-B In applications are an integral part of the future National Airspace System (NAS)**
- **ADS-B In supports increased pilot situational awareness, traffic alerting, and operational efficiencies in the NAS today**
- **Current challenges facing future applications include benefits demonstration, funding requirements, and industry consensus**
- **FAA continues to support when possible**
  - Currently leveraging opportunity to assess benefits including a public-private partnership to demonstrate operational feasibility and value of an ADS-B In (see upcoming slide 24)

TSO-C195b ADS-B-In Applications

In Trail Procedures (ITP)

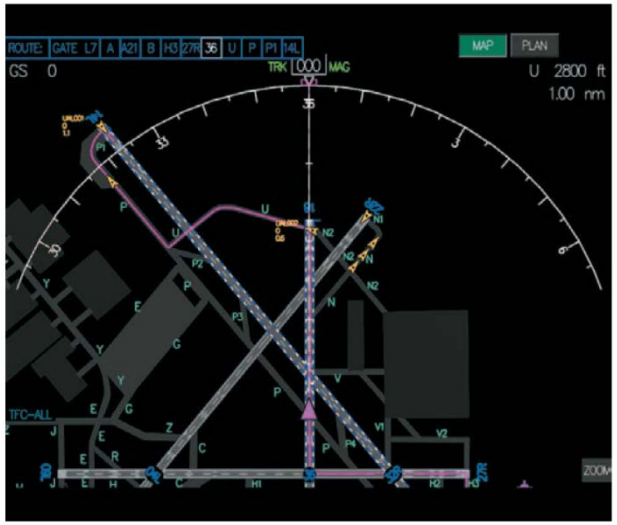


Traffic Situation Awareness with Alerts (TSAA)



Cockpit Display of Traffic Information- Assisted Visual Separation (CAVS)

SURF



AIRB

Advanced Interval Management (A-IM)

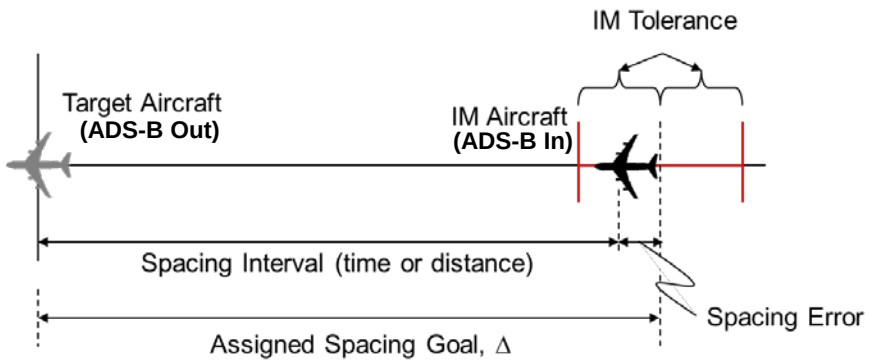
Arrivals & Approach | Flight-deck Integration | DataComm

Description: Develop advanced applications to enable relative spacing ground and airborne capabilities for implementation into the NAS in the mid-term environment

Goals: Maximize airspace throughput and reduce delays in the NAS

Objective: Publish A-IM SPR, MOPS (avionics standards)
Integrate A-IM ConOps

Partners: FAA, RTCA SC-186/WG-4, SC-214/WG-78, SC-227



Key Project Milestones

Complete | In Progress | Not Yet Started

- Draft Revised Functional Requirements Oct 2017
- A-IM ConOps Oct 2017
- A-IM Initial Rqmts (iPR) Apr 2018
- Initial FIM MOPS v2 Oct 2018
- A-IM Paired Approach HITL Report Q2 FY19
- MOPS Integrated Test Procedures Q1 FY20
- Final SPR/MOPS publication FY20

FAA-AAL-ACSS ADS-B In Retrofit Spacing Evaluation

Description: Operational evaluation of partial IM spacing capabilities and CAVS for arrivals into PHX using certified ACSS equipment on AAL A321 aircraft (entire fleet)

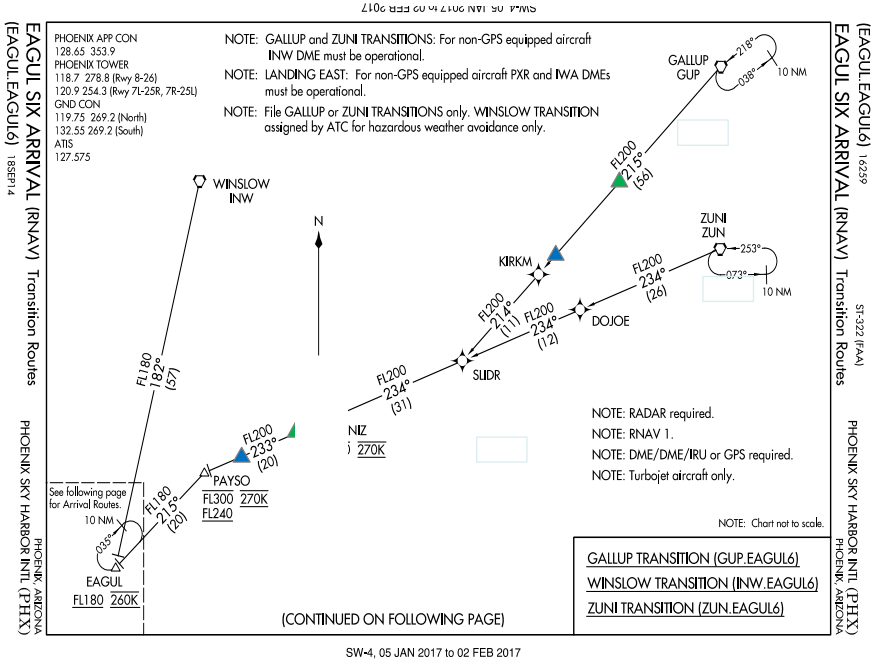
Goal: Demonstrate operational feasibility and value of an ADS-B In retrofit solution that could enable early adoption of IM, CAVS and other ADS-B In applications

Objectives: Promote adoption of ADS-B In applications

Support ADS-B In industry initiatives by gathering data in an operational environment

Gather insight for building FAA business case for IM

Partners: FAA, NATCA, ACSS, AAL



Operational evaluation proposed for AAL westbound arrivals through Albuquerque Center to PHX

Key Project Milestones

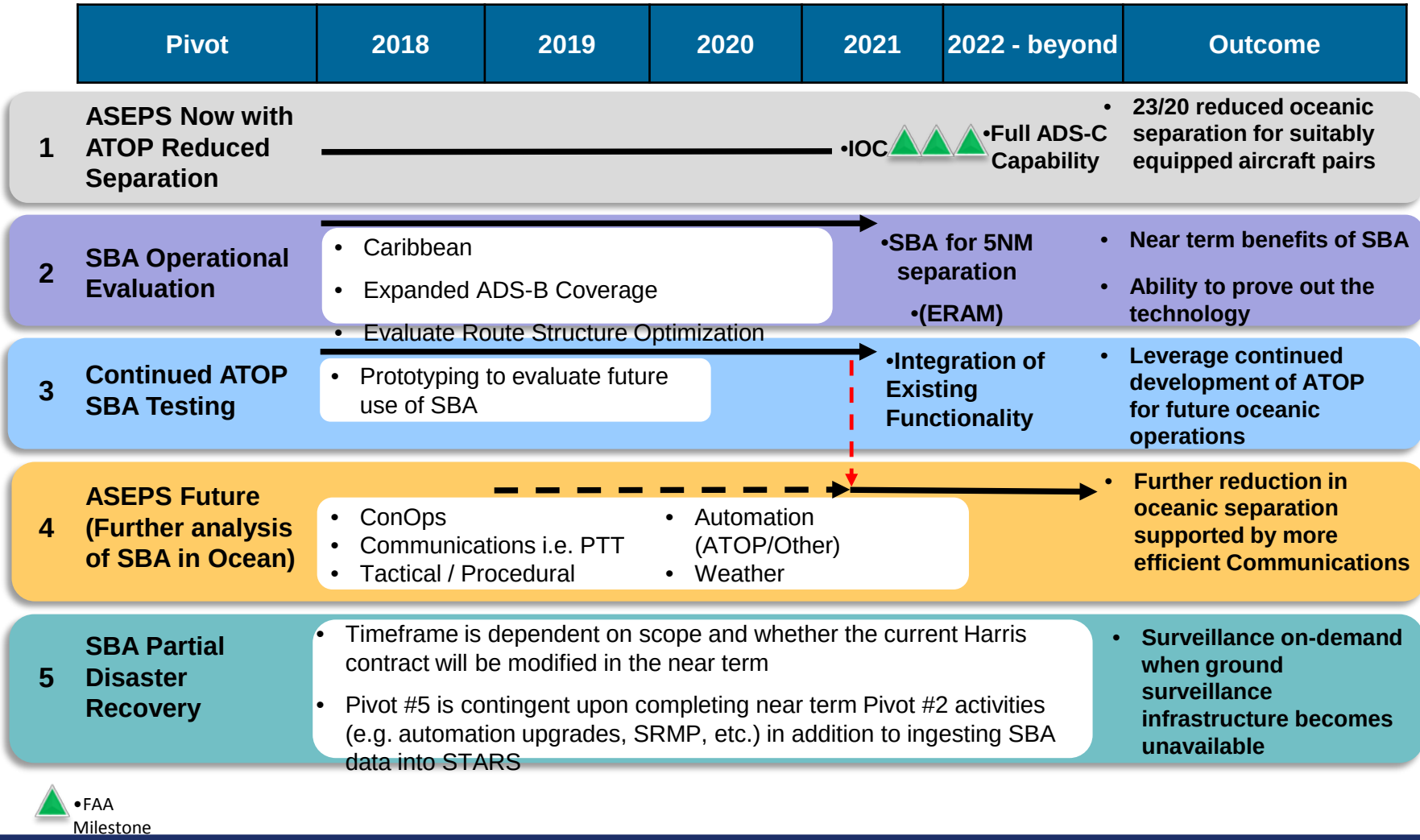
Complete | In Progress | Not Yet Started

Signed Planning MOA	Signed Funding MOA	AAL Funding Approval	Avionics TSOA & STC	Initiate CAVS Operations	Adequate AAL Equipage for Spacing	Initiate ZAB/PHX Spacing Ops	Complete Benefits Analysis
Jul 2016	Sep 2017	Nov 2017	Q1 FY19	Q4 FY19	Projected Q4 FY20	Projected Q4 FY20	Q4 FY21

What Has Changed for ASEPS

- **Original Scope for ASEPS: Reduced oceanic separation service below 30 nautical mile (NM) lateral and 30 NM longitudinal separation (30/30) to enhance operations in U.S. oceanic airspace using Space-based ADS-B (SBA) and/or ADS-C with an increased update rate**
- **FAA recognizes the benefits of SBA and its potential for the future in the U.S. and internationally**
- **FAA also has a need to better prove out the SBA technology before committing to a long-term investment, due largely to operational constraints and a current lack of operational need**
  - ANSP handoff coordination is efficient today
  - No capacity issue exists today or is expected in the future
  - Reduced separation is constrained by convective weather
  - FANS 1/A equipage is too low in certain airspace (e.g. FANS 1/A equipage in WATRS is projected to be 76% by 2020)
  - Communication latency and controller reaction time limit how oceanic airspace can be managed
  - Unmitigated safety hazards exist
- **This led FAA to a strategic shift (Pivots), identifying short-term opportunities to leverage work done to date that contribute to a long-term solution in the future**

New Strategy / Pivot Overview



ASEPS Path Forward

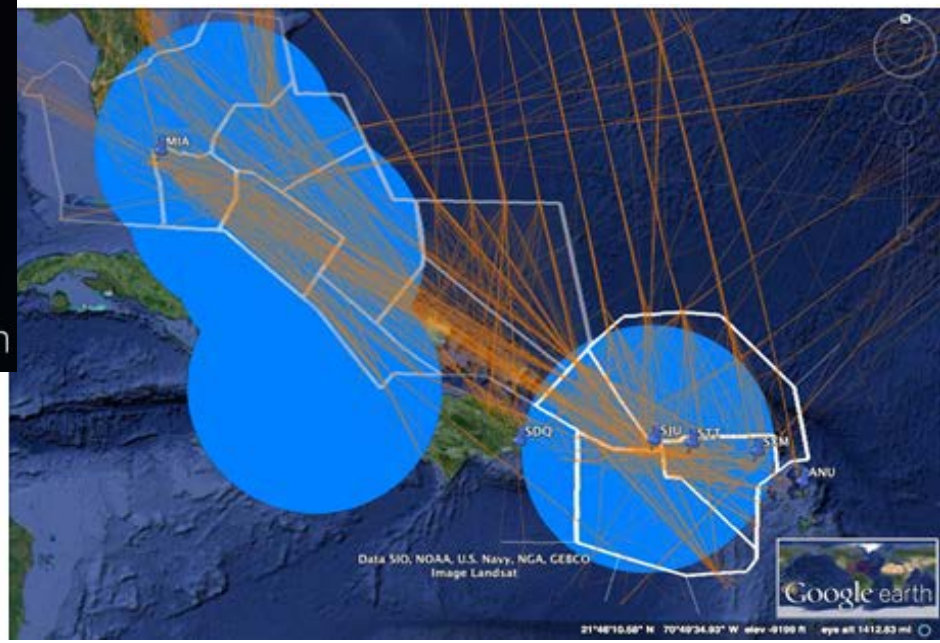
SBS ASEPS has been approved to proceed with the following activities:

- **Pivot #1:** Proceeding to a Final Investment Decision (FID) on ADS-C 23/20 in February 2019
- **Pivot #2:** Initiating near-term Operational Evaluation (Op Eval) of space-based ADS-B (SBA) in the Caribbean on ERAM
- **Pivot #3:** Maturing and continuing ATOP SBA testing activities
- **Pivot #4 and #5:** Exploring and maturing long term strategies for future analysis of SBA in the ocean and a partial disaster recovery capability

FAA-managed Caribbean Airspace

Figure 1: Caribbean Airspace Sectors

Figure 2: Grand Turk Surveillance Gap

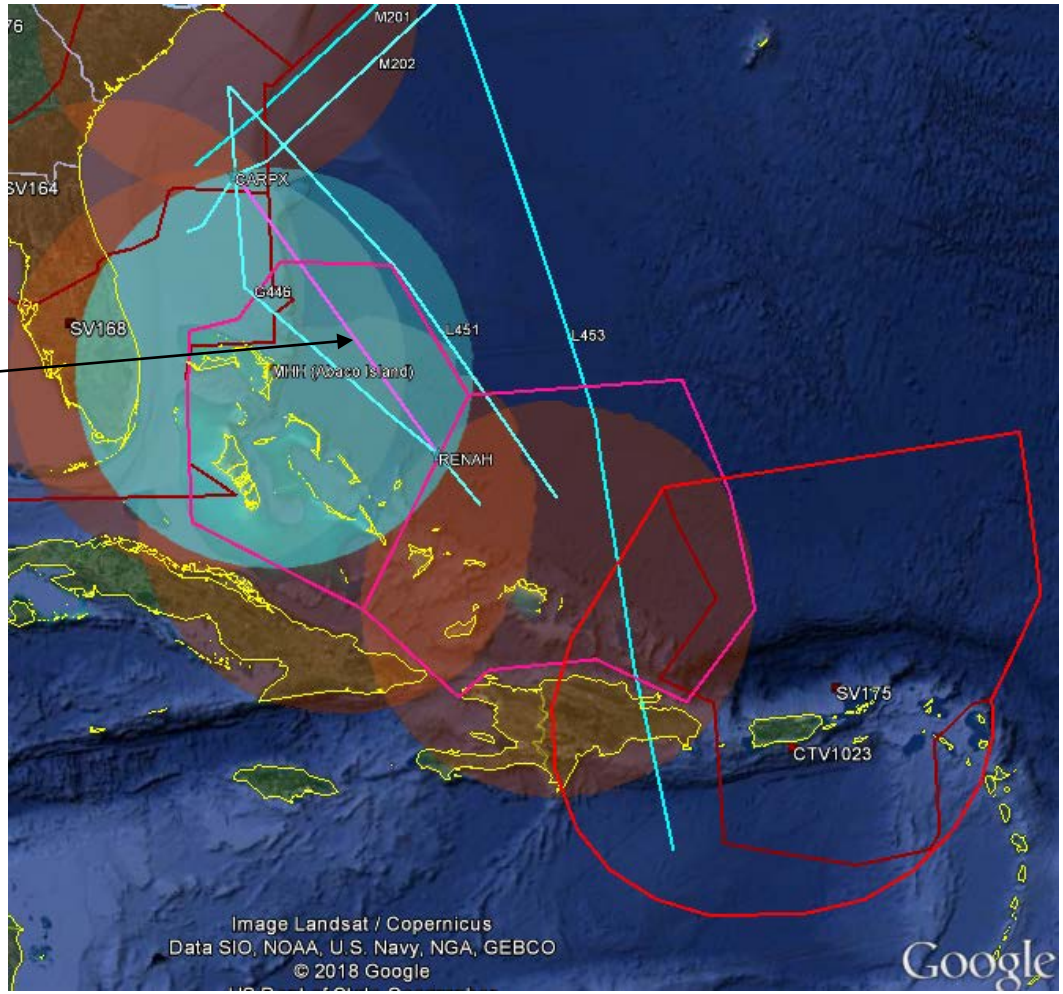


Caribbean Airspace Optimization and Potential VHF Communications Coverage

Key:

Potential VHF Comm Coverage (shaded area)

Proposed shortcut route



Discontinuing FAA Services to LV1 aircraft

- **Aircraft equipped with ADS-B Out Version 1 will no longer receive the following services after January 1, 2020**
  - ATC surveillance services using ADS-B (impacts Alaska and Gulf of Mexico only)
  - ADS-SLR (impacts all airports with ASDE-X and ASSC)
  - TIS-B and ADS-R Client services (NAS-wide impact)
- **Also, requirement that NACv>0 to receive TIS-B/ADS-R Client services will be reinstated (see 2016 TIS-B Service Change Summary posted in RGL on TSO-C195b page)**
- **FAA will begin making above changes on January 2, 2020**
  - Since changes require implementation of software revisions and some require changes at multiple locations NAS-wide, all changes will not be completed on January 2, 2020, but sometime soon thereafter

- **Notice FAA-2018-0914 appeared in the Federal Register on 5-Nov-2018**

FAA Next Steps

- **Continue rollout of Air Traffic Control Separation Services**
- **Monitor avionics compliance and work with industry on the *Equip 2020* initiative**
- **Prepare for JRC requests**
  - Various ASEPS Pivot Strategy decisions (slide 26)
  - A-IM Strategy decision
  - Final Investment Decision for the Next Segment of the “Baseline” SBS Program (FY20-25 funding)

Operator Next Steps

- **Considerations for the U.S. ADS-B mandate**
  - **Version 2 ADS-B transmitter**
  - **Compliant position source approved to “pair” with V2 ADS-B transmitter**
  - **Aircraft wiring as needed**

- **1 year, 20 days to go!**

Acronyms

ADS-B: Automatic Dependent Surveillance – Broadcast
ADS-R: Automatic Dependent Surveillance – Rebroadcast
AML: Approved Model List
APB: Acquisition Program Baseline
ASSC: Airport Surface Surveillance Capability
ATC: Air Traffic Control
ATOP: Advanced Technologies and Oceanic Procedures
ConOps: Concept of Operations
ES: Extended Squitter
FIM-S: Flight Deck Based Interval Management – Spacing
FIS-B: Flight Information Services - Broadcast
GIM-S: Ground-Based Interval Management – Spacing
GOM: Gulf of Mexico
IOC: Initial Operating Capability
ISAT: Implementation Service Acceptance Test
ITP: In Trail Procedures
MFD: Multi-Function Display
MHz: Megahertz
MOPS: Minimum Operational Performance Standards
NCT: Northern Cal TRACON
NM: Nautical Mile
O&M: Operations and Maintenance
PED: Portable Electronic Device
RIO: Risks, Issues, and Opportunities
SBS: Surveillance and Broadcast Services
SFO: San Francisco International Airport
STC: Supplemental Type Certificate
SVR: Service Volume Rollout
TAMR: Terminal Automation Modernization and Replacement
TIS-B: Traffic Information Services - Broadcast
TRACON: Terminal Radar Approach Control
TSAA: Traffic Situation Awareness with Alerts
UAT: Universal Access Transceiver